Update on NCEP Global OSSEs

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RS Information Systems

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http://www.emc.ncep.noaa.gov/research/osse

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Observing Systems Simulation Experiments

http://www.emc.ncep.noaa.gov/research/osse/OSSEDIAG.gif

Topics Covered

About NCEP Global OSSEs

Formulation of simulated observation errors

Assessment of Doppler Wind Lidar impact

Evaluation of the results

Observation used for initial OSSEs

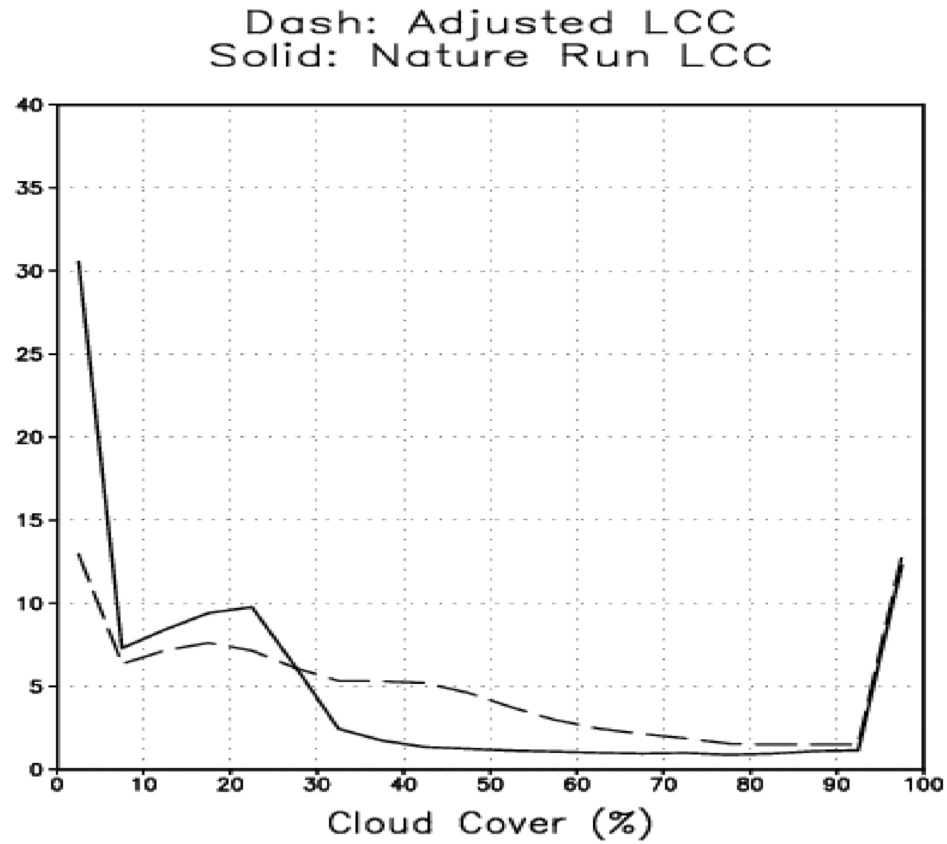
Use distribution of real observations in February 1993
RAOB and other conventional data
ACARS (1993 distribution)
HIRS and MSU level 1B data from NOAA-11, NOAA-12
Satellite cloud track wind
Surface observations

Nature Run

ECMWF reanalysis model
Resolution T213 (about 60 km), 31 levels
06Z 5 February 1993 to 00Z 7 March 1993
  Near normal condition
  Good agreement in synoptic activities

Marine stratocumulus adjusted

Other NR will be introduced
after OSSE by ECMWF NR is exploited



Frequency distribution for ocean areas containing low level cloud cover in 20, 5%-band, categories. Solid line: NR cloud cover without adjustment. Dashed line: with adjustment.

The data assimilation system

Operational NCEP data assimilation system
March 99 version.
T62/ 28 level

Getting ready to move on to the current operational SSI

Further Plans

- Development of situation-dependent background error covariances for global and regional systems.
- Bias correction of background field
- Improved moisture background error covariance
- Development of cloud analysis system

Benefits of running OSSEs

(beyond instrument evaluation)

- Prepare for real data
  (formats, data flow, analysis development)

- Some prior experience for new instrument

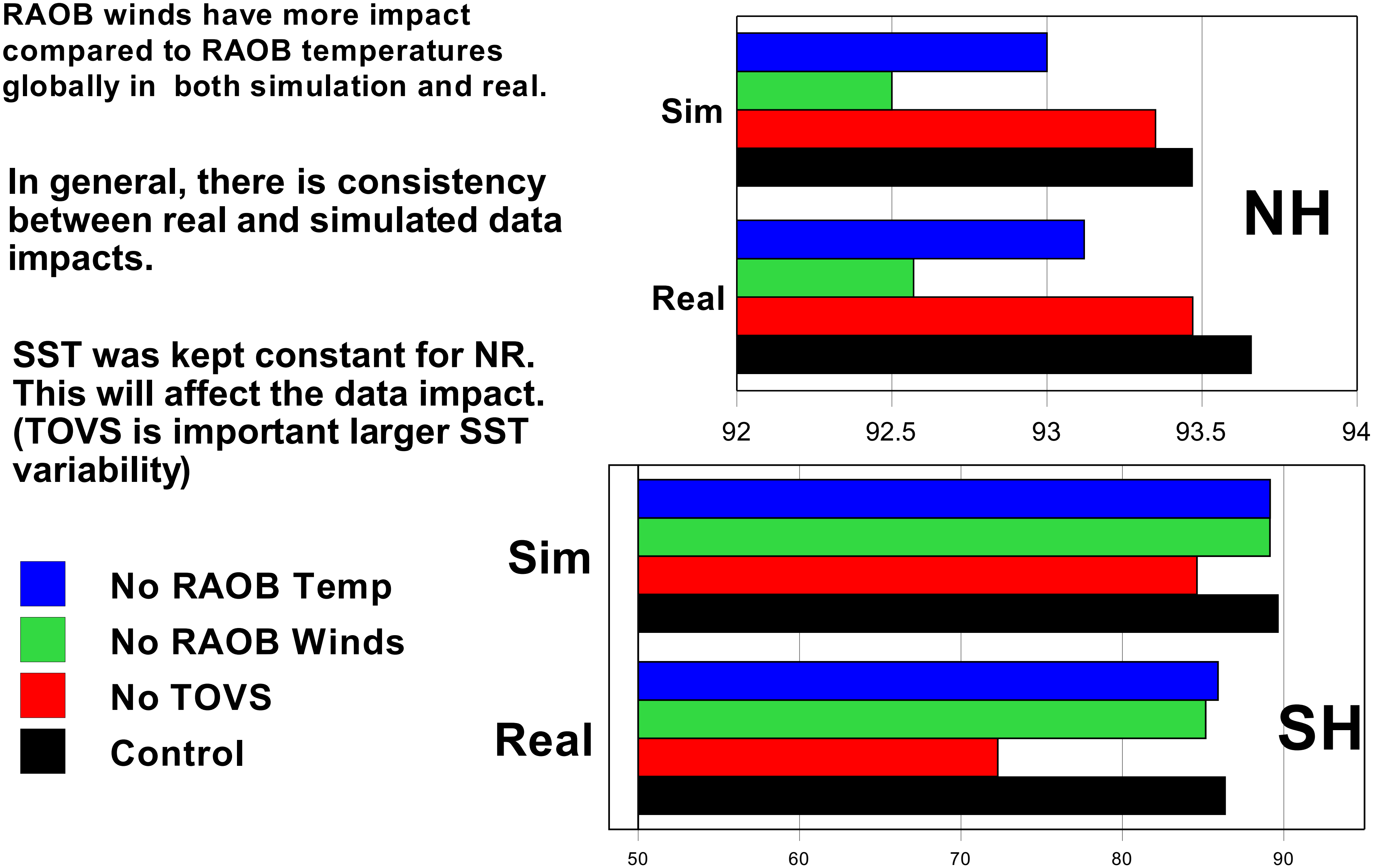
- Data impact tests with known truth will reveal negative impacts some data sources.

- Design advanced strategies of observing
  systems and
  data assimilation (e.g. THORPEX)

RAOB winds have more impact compared to RAOB temperatures globally in both simulation and real.

In general, there is consistency between real and simulated data impacts.

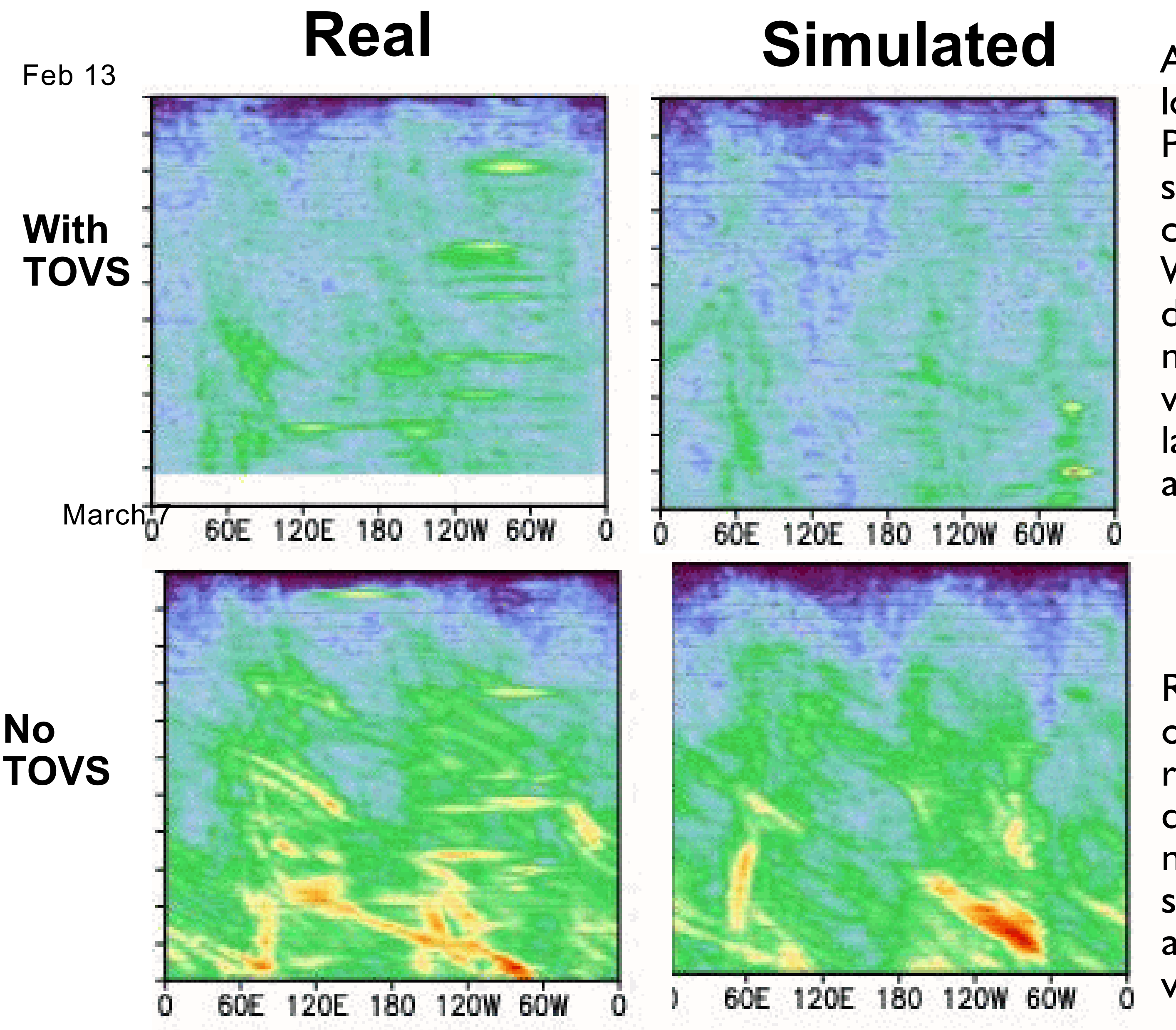
SST was kept constant for NR. This will affect the data impact. (TOVS is important larger SST variability)



Anomaly correlation between control analysis and 72 hour forecasts for 500 hPa height.

NCEP/EMC DWL Work June 2003

Heiht averaged between 700mb and 300mb for (80S-20S)
Difference between analysis with real SST and constant SST



Anomalous warm localized SST in SH Pacific in REAL SST. In simulation experiment constant SST is used. With TOVS data the difference is small in mid troposphere but without TOVS data, large differences appear and propagate.

Real and simulated observations are responding to two different SST in similar manner. Therefore, simulated experiments are valid for slow varying SST.

Systematic Errors

OSSE data impact depends on error formulation for simulated observations. Random error is easy to produce but it is not challenging enough for data assimilation systems. Need to include systematic large scale errors.

Skill may be sensitive to systematic error added to the upper air data.

Errors in Surface data

The error in real surface data is much larger than simulated surface data. Therefore, impact of other data, particularly satellite data including DWL, may be underestimated in simulation.

Error Adjustment Technique

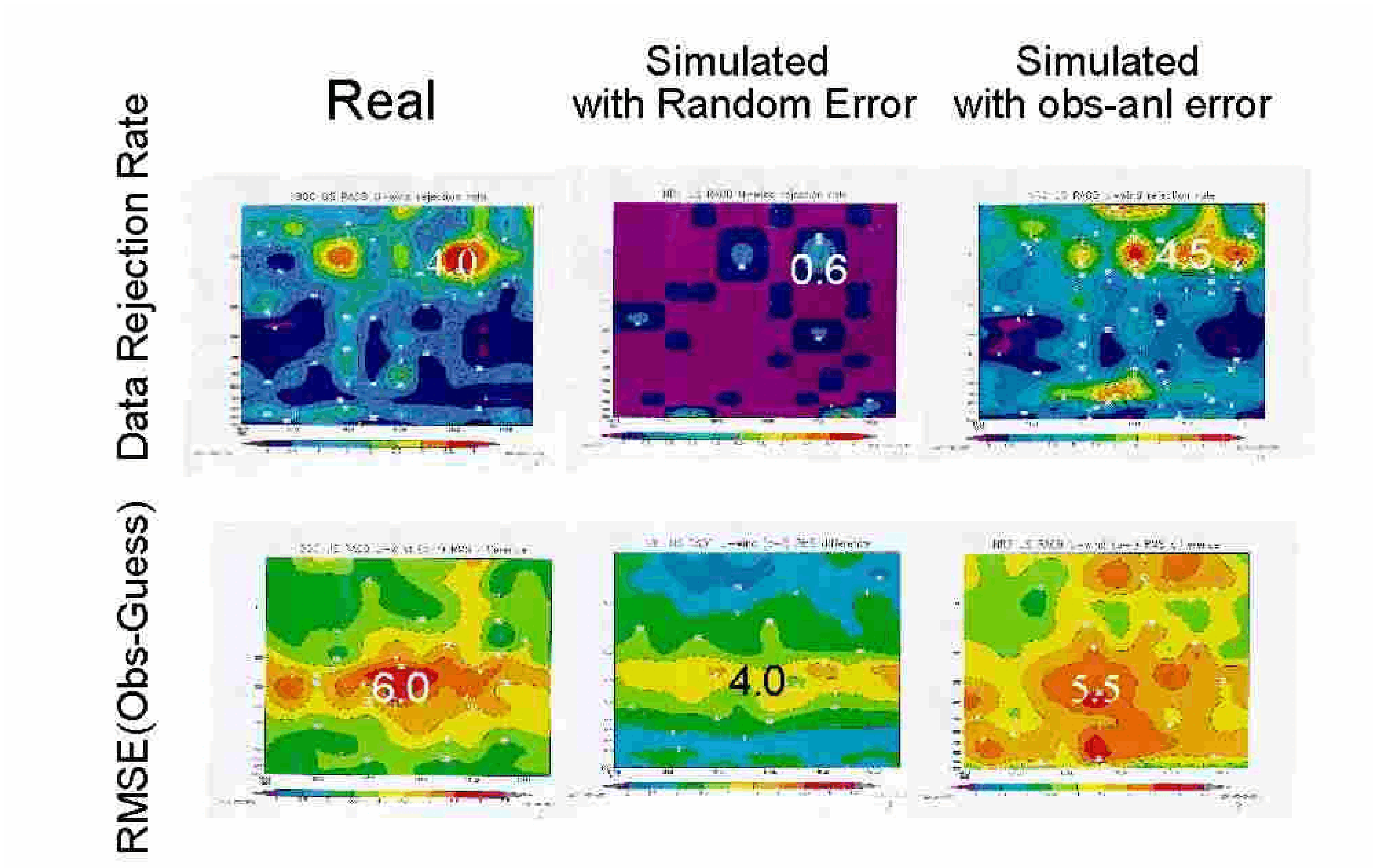
Adjust error based on Obs-analysis (o-a) from real data to add systematic errors

Random error proportional to Reresentativeness error

Add different error for each observation type

The adjusted data presented in this paper

Surface synoptic: Random error+1.0*(o-a)
Ship data: 1.0*(o-a)
Upper air synoptic data:
Adj: 0.5*(o-a), Adj_1:1.0*(o-a), Adj_2: 2.0*(o-a)

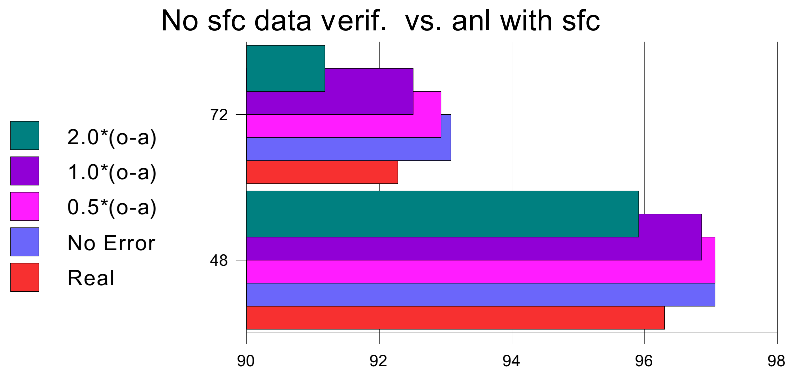


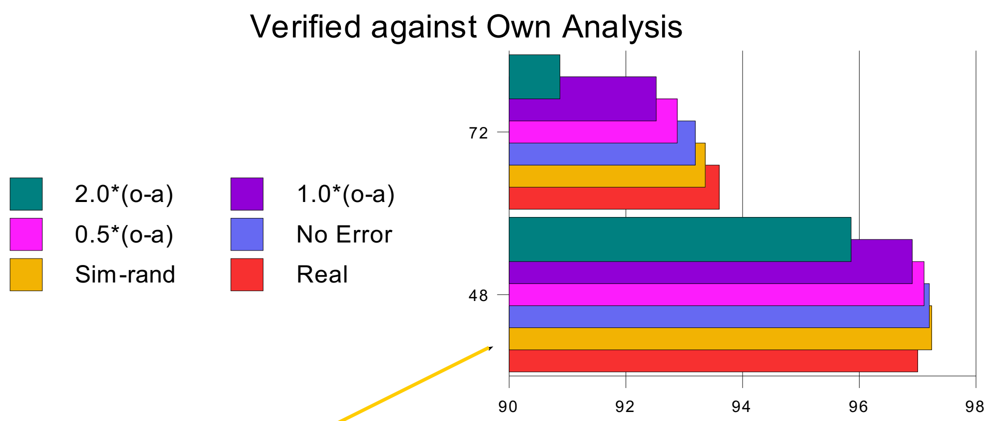
Top) Area averaged rejection rate for over US. Bottom) Area averaged values for RMSE between observation and guess fields. The values are computed for zonal wind from RAOB.

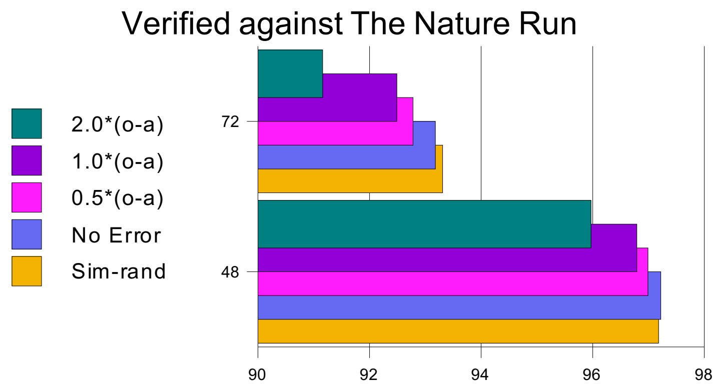
Impact of Surface data

Anomaly correlation for z500

1.0*(obs-anl)+Random for surface and 2.0*(obs-anl) for upper air data
1.0*(obs-anl)+Random for surface and 1.0*(obs-anl) for upper air data
1.0*(obs-anl)+Random for surface and 0.5*(obs-anl) for upper air data
Perfect data with surface data at real surface
Real







Simulated with Random error with surface data at NR topography. Used for Experiments with DWL.

Impact Assessment of a DWL

Simulation of DWL wind

All levels (Best-DWL): Ultimate DWL that provides full tropospheric LOS soundings, clouds permitting.

DWL-Upper: An instrument that provides mid and upper tropospheric winds only down to the levels of significant cloud coverage.

DWL-PBL: An instrument that provides only wind observations from clouds and the PBL.

Non-Scan DWL : A non-scanning instrument that provides full tropospheric LOS soundings, clouds permitting, along a single line that parallels the ground track.

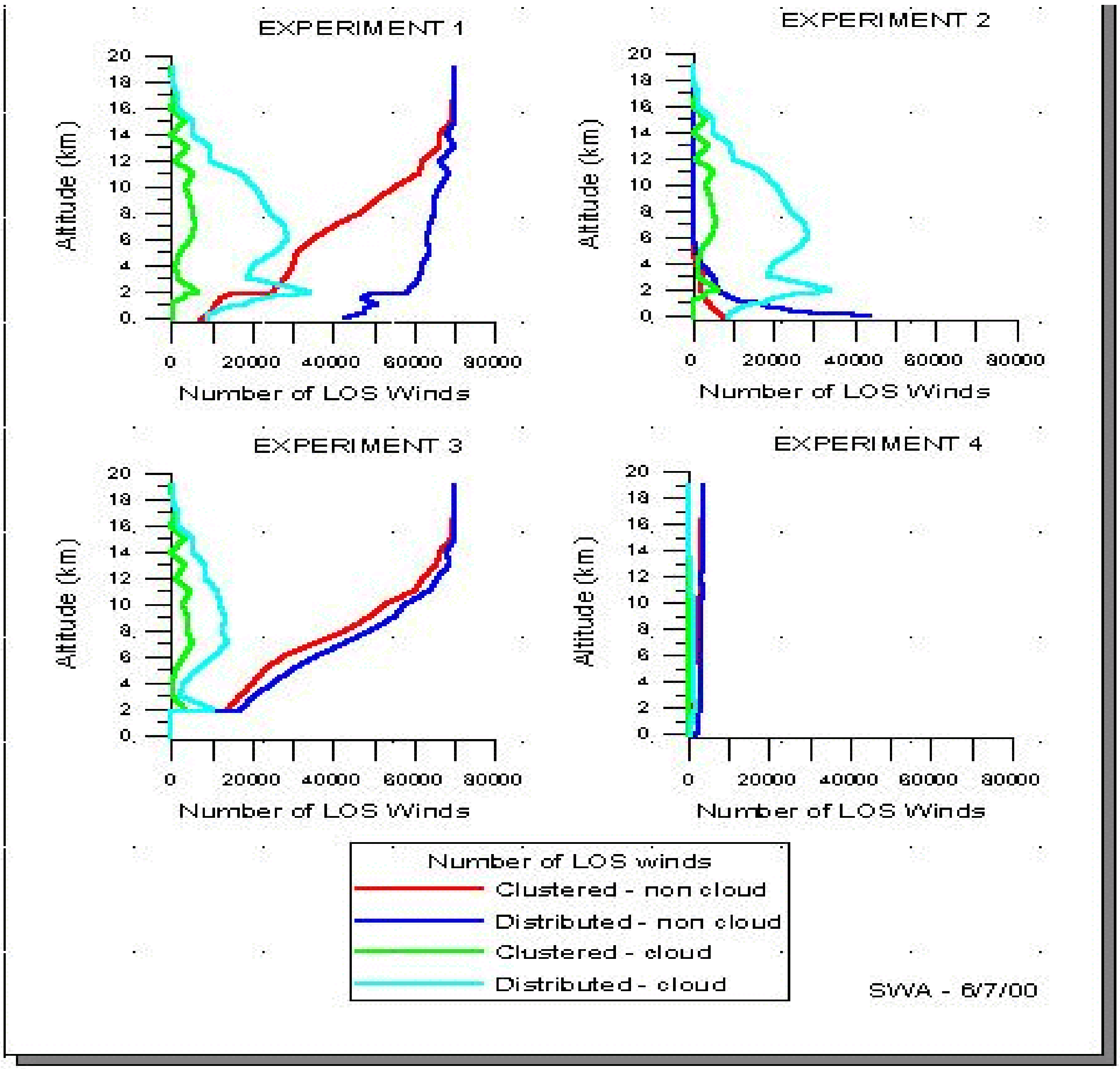
One measurement is an average of many shots (LOS)
(Between 50 to 200)

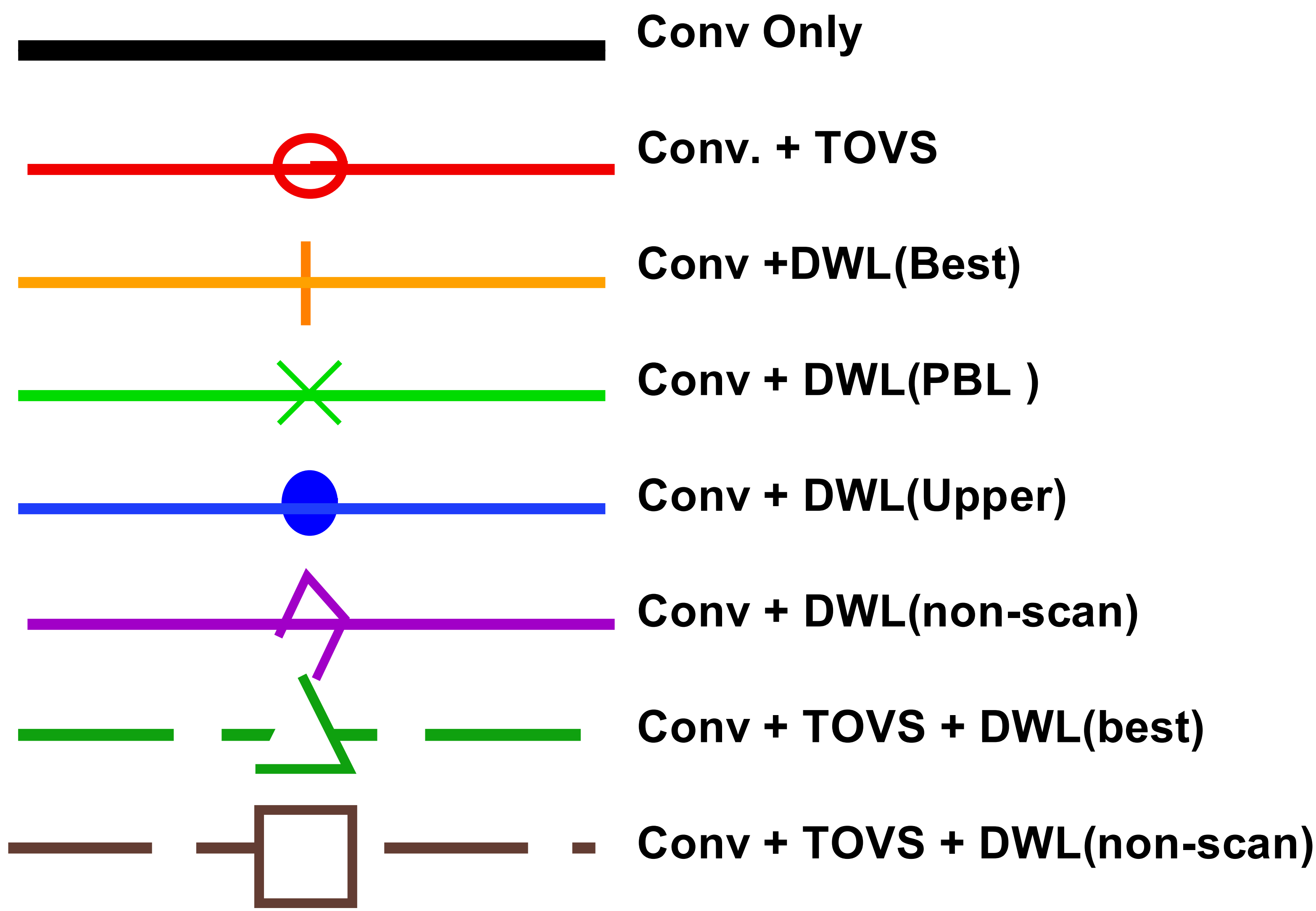
Targeted Resolution Volume (TRV)
200Km x 200Km x T (Km)
T: Thickness of the TRV
0.25 Km if z<2 Km, 1 Km if z> 2 Km, 0.25 Km for cloud return

Swath Width: 2000 Km

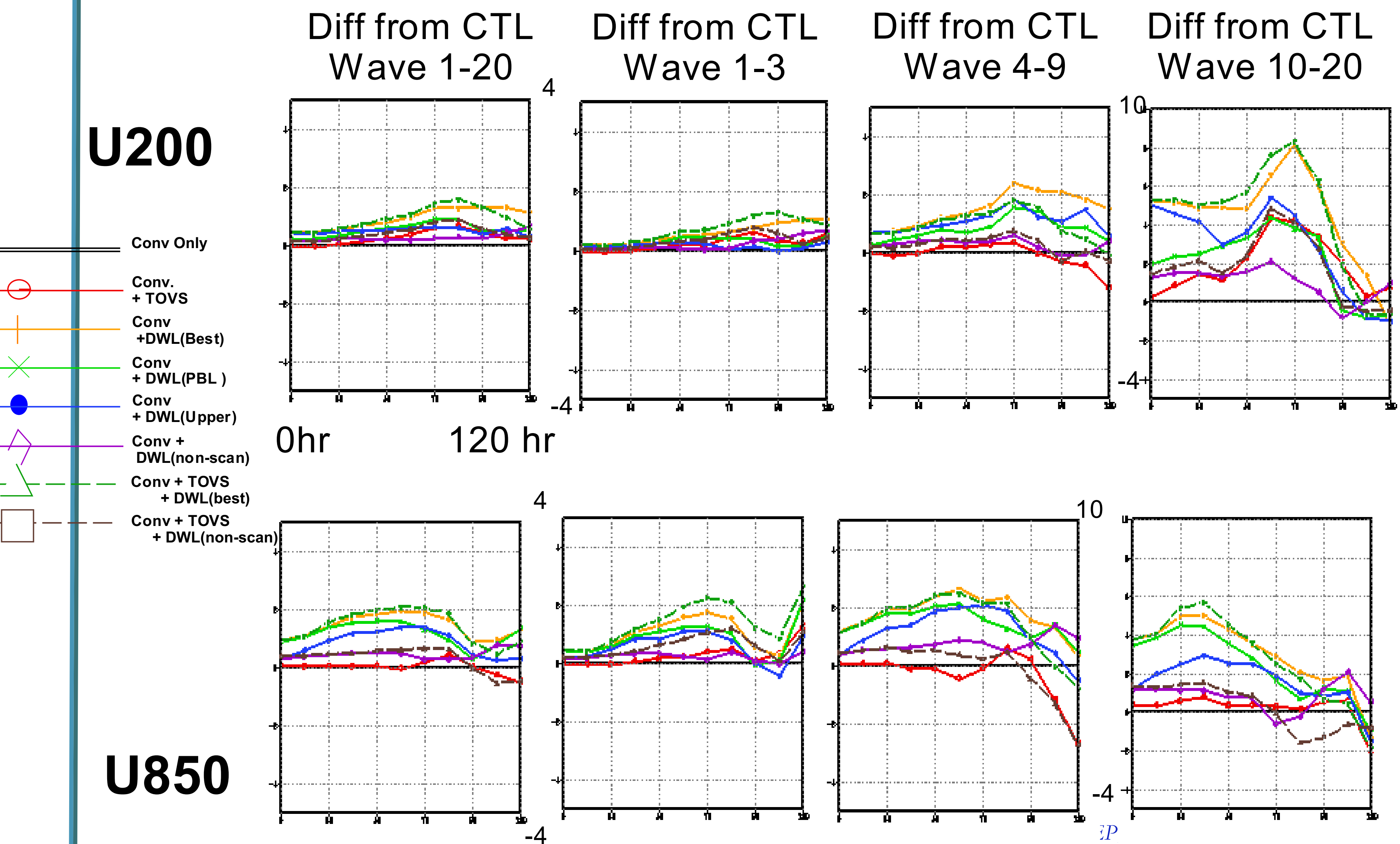
The original simulated data without adjustment is used for the DWL impact test presented today.

Number of DWL LOS Winds
2/12/93

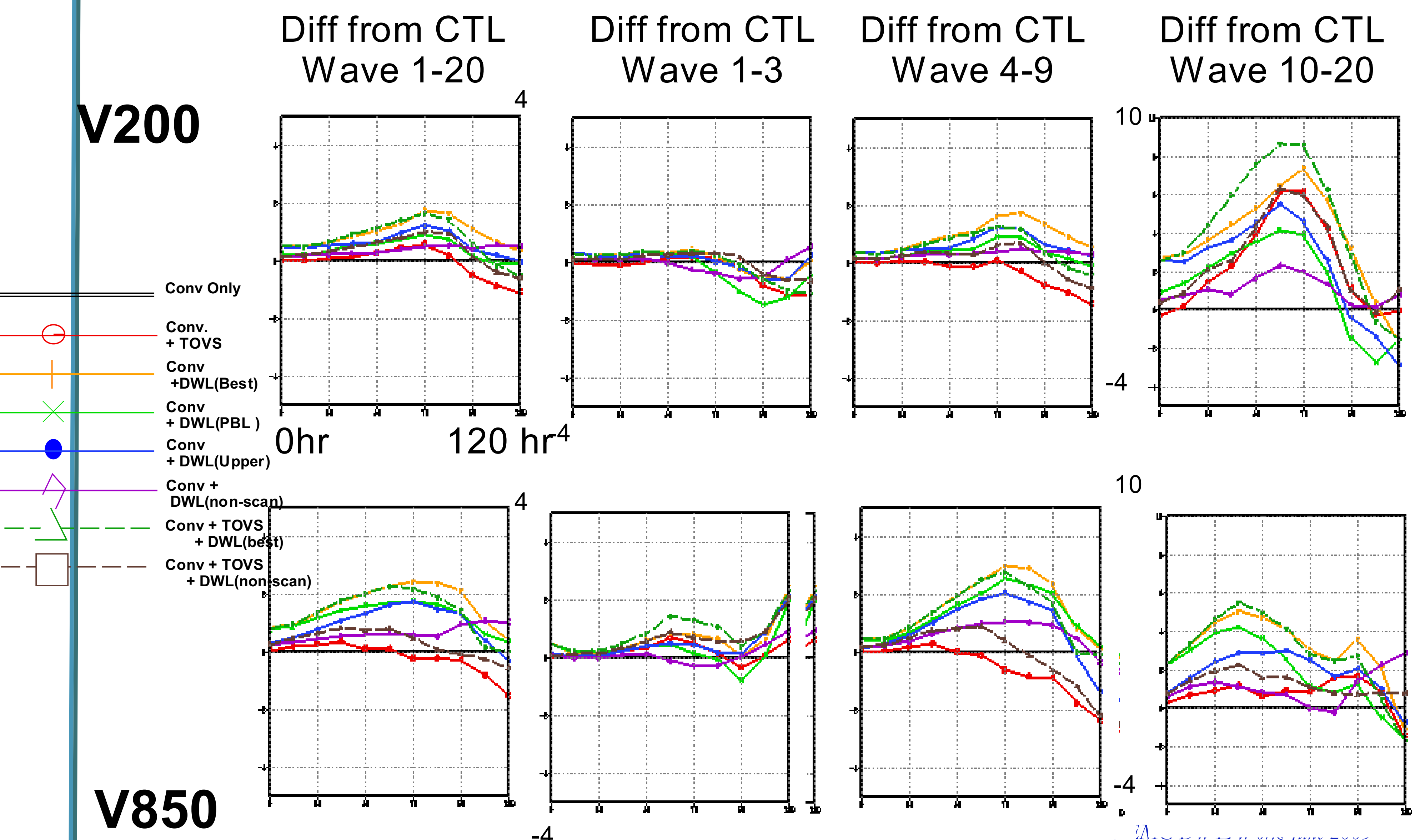



Conv Only
Conv. + TOVS
Conv +DWL(Best)
Conv + DWL(PBL)
Conv + DWL(Upper)
Conv + DWL(non-scan)
Conv + TOVS + DWL(best)
Conv + TOVS + DWL(non-scan)

Anomaly correlation in NH extratropics (20N-80N)

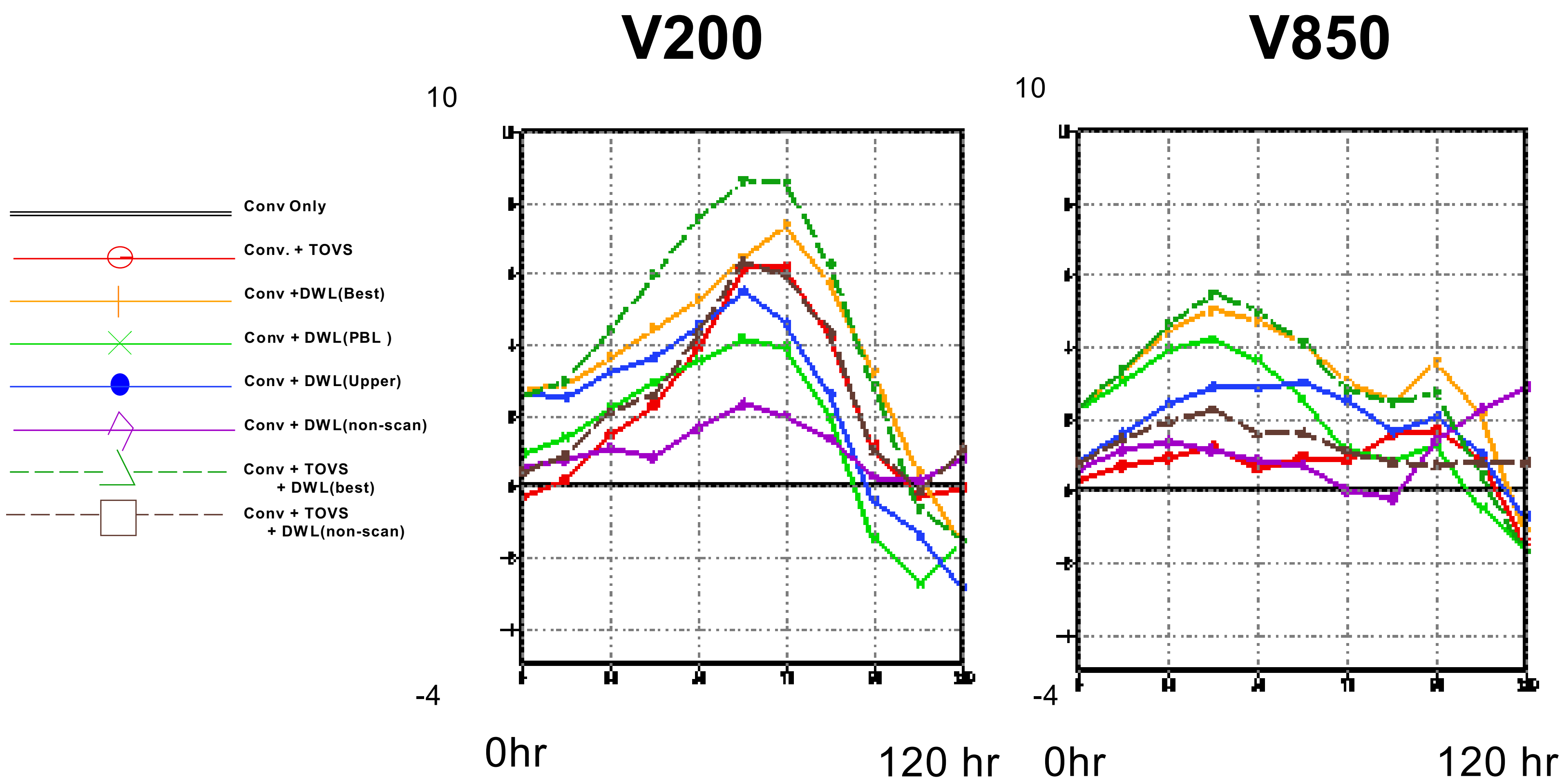


Anomaly correlation in NH extratropics (20N-80N)

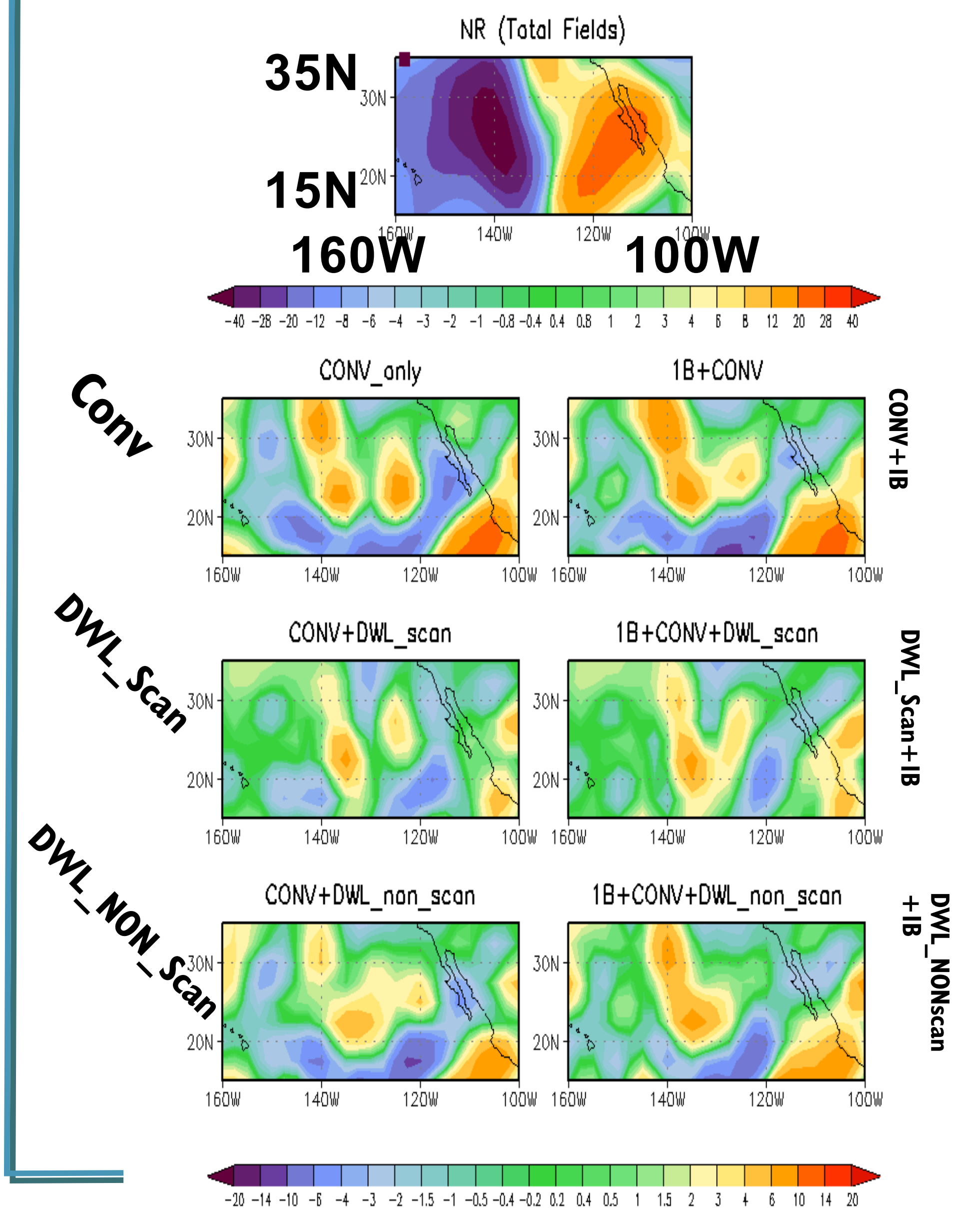


Anomaly correlation in NH extratropics (20N-80N)

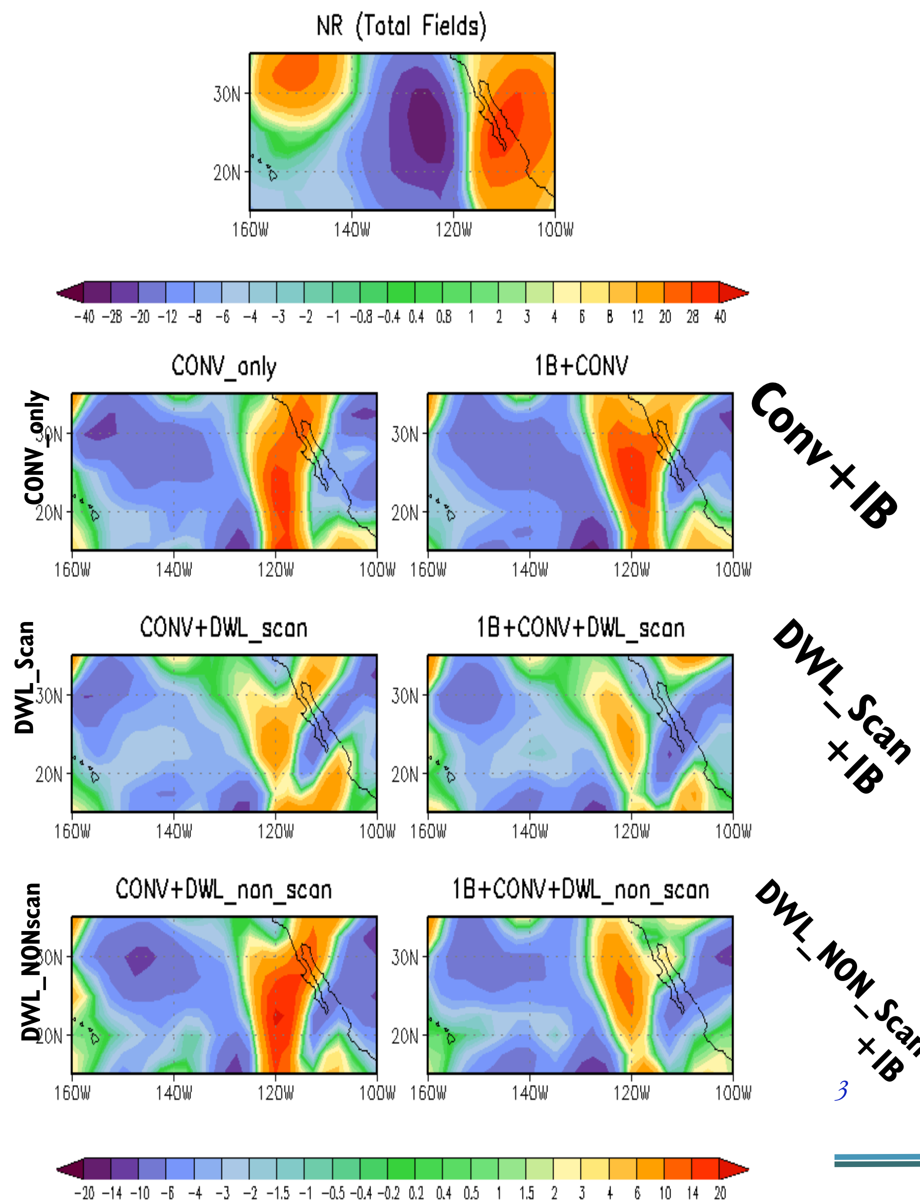
Diff from CTL zonal wave number 10-20



V 200 Analysis fields on 00Z Feb. 26 Difference from NR

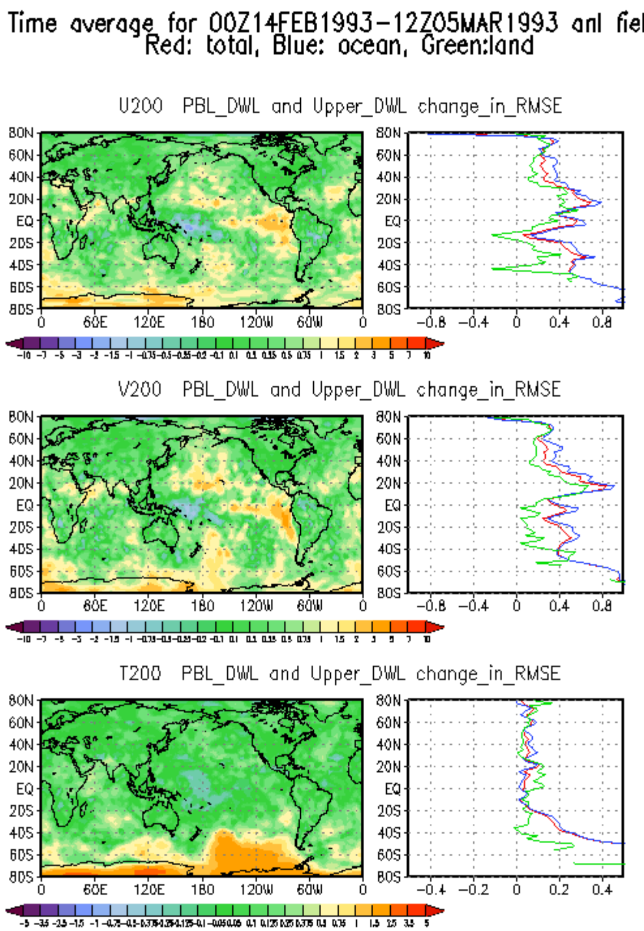


V 200 48hr fcst fields on 00Z Feb. 28 Difference from NR

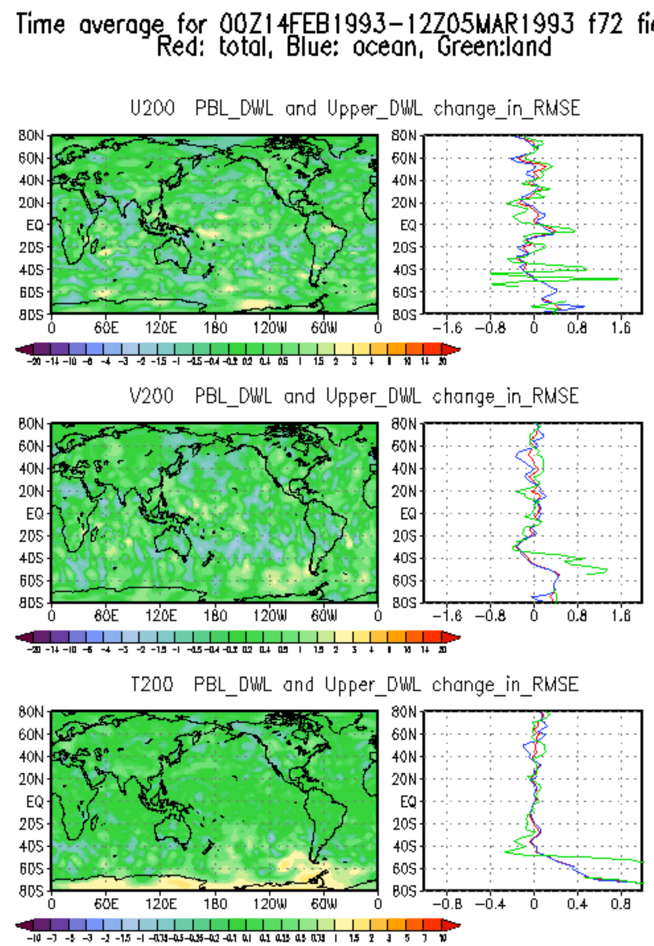


Change in RMSE from NR (run_left-run_right): 200hPa
Diagram: Zonally averaged Green:land, Blue:ocean, Red:total

CTL+DWL_PBL:CTL+DWL_upper
Analysis

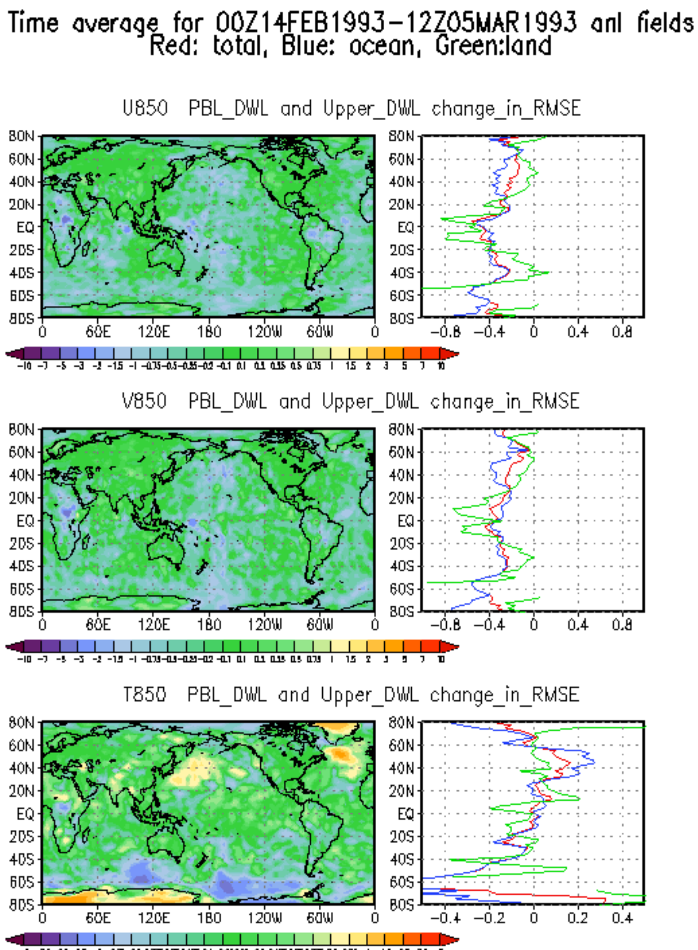


CTL+DWL_PBL:CTL+DWL_upper
72 hour forecast

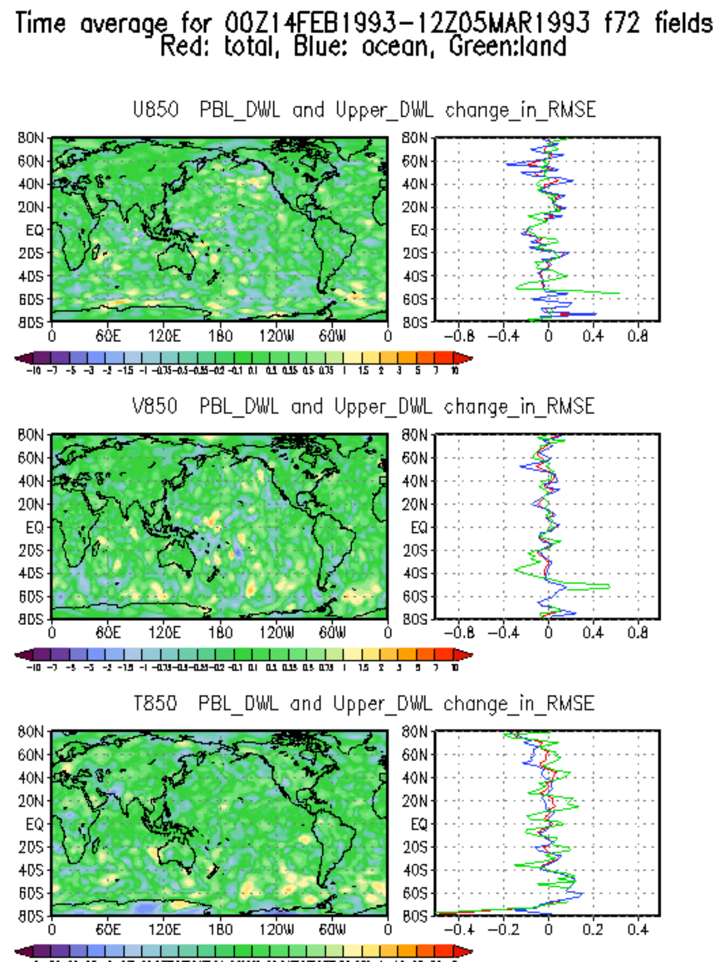


Change in RMSE from NR (run_left-run_right): 850hPa
Diagram: Zonally averaged Green:land, Blue:ocean, Red:total

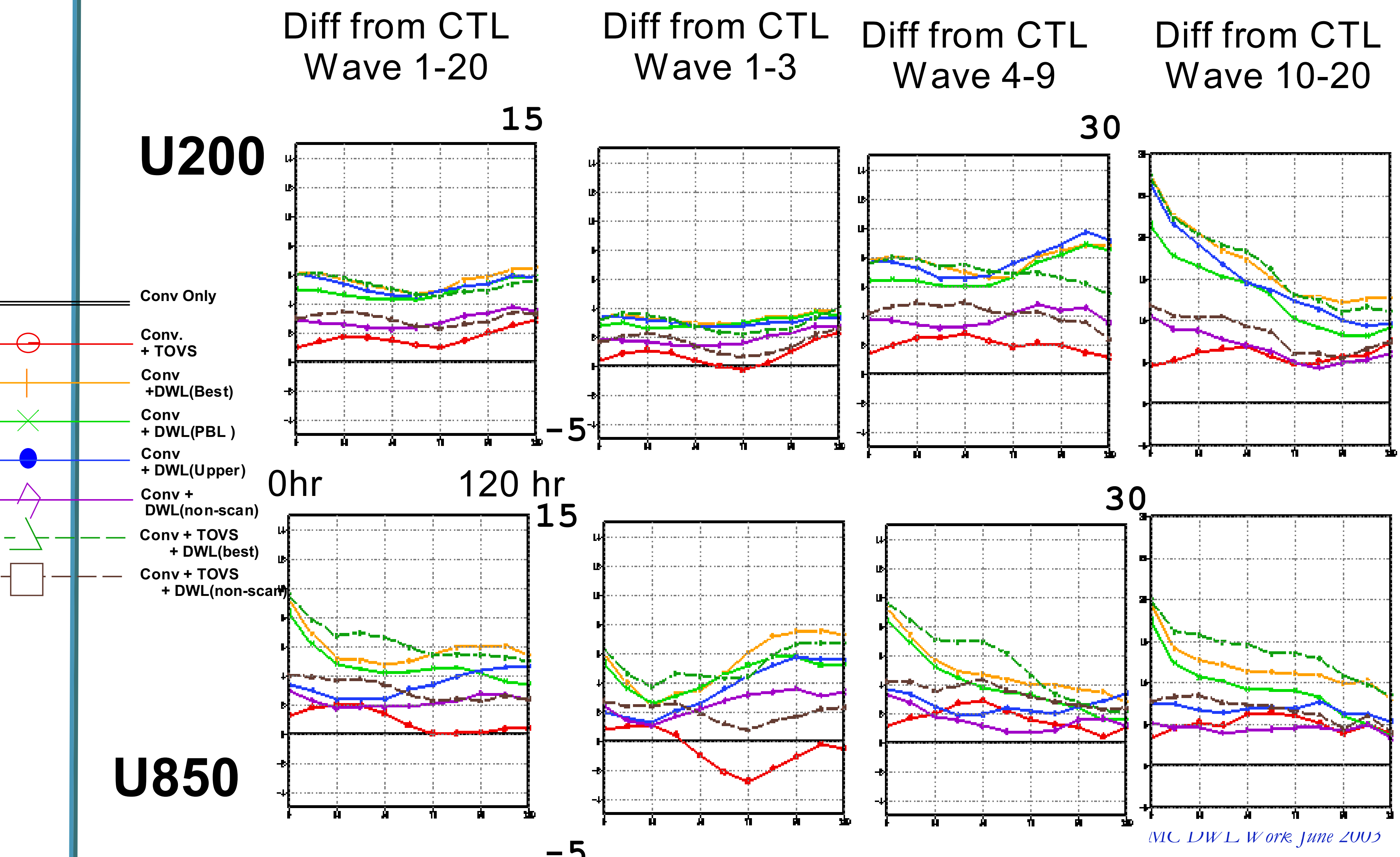
CTL+DWL_PBL:CTL+DWL_upper Analysis



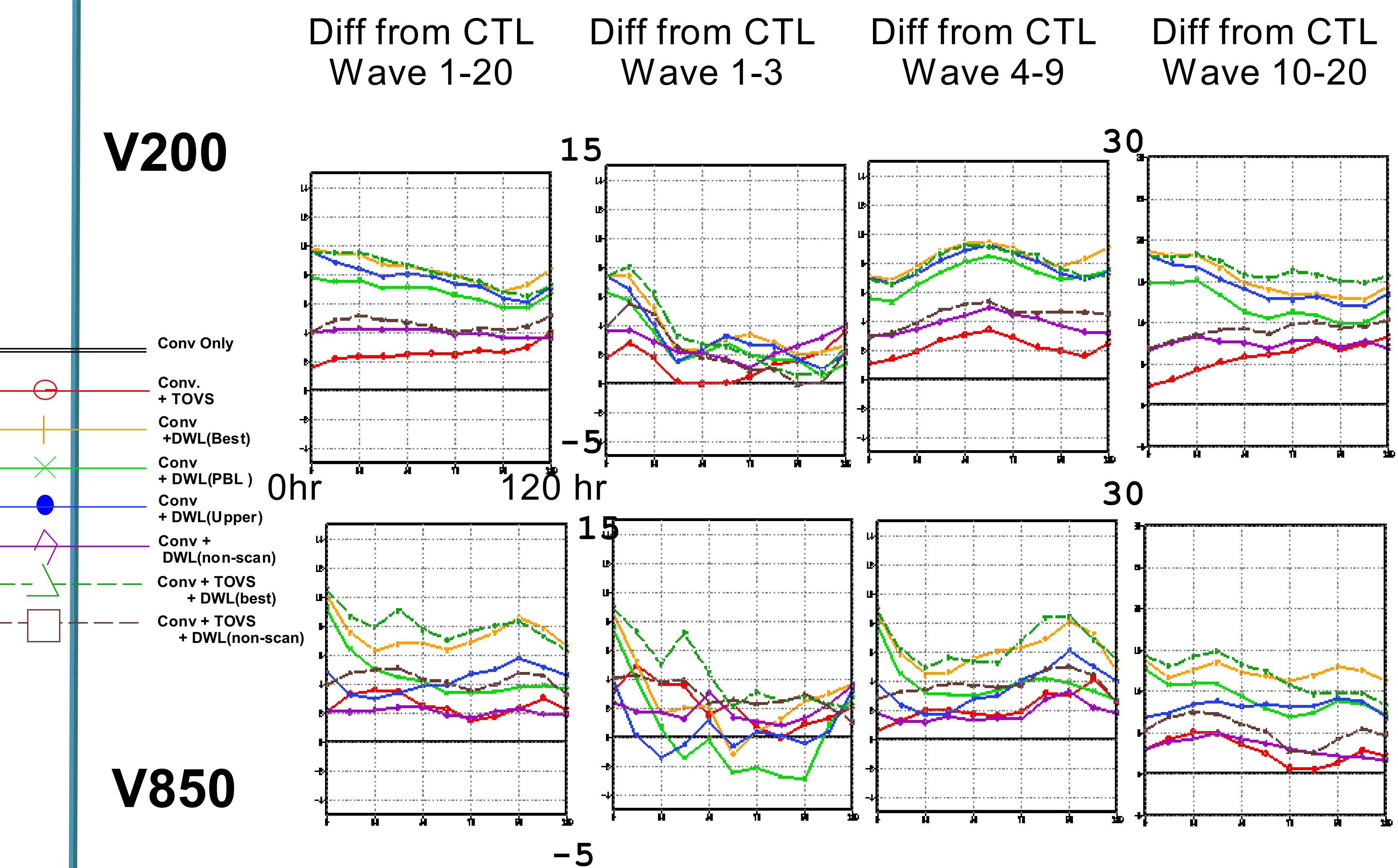
CTL+DWL_PBL:CTL+DWL_upper 72 hour forecast



Anomaly correlation in Tropics (20S-20N)



Anomaly correlation in Tropics (20S-20N)



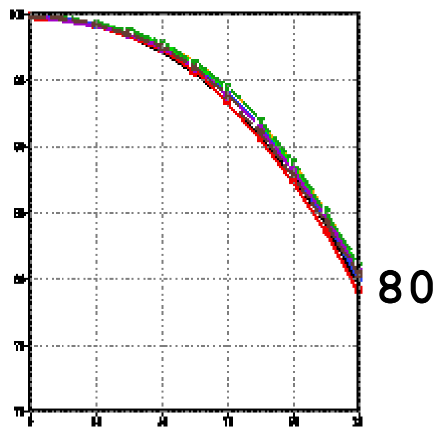
Anomaly correlation in SH extratropics (80S-20S)

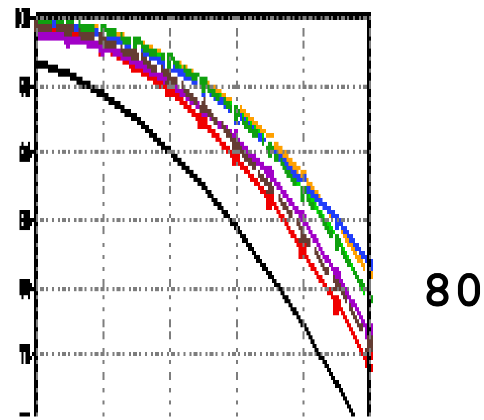
Z500 (Wave:1-20)

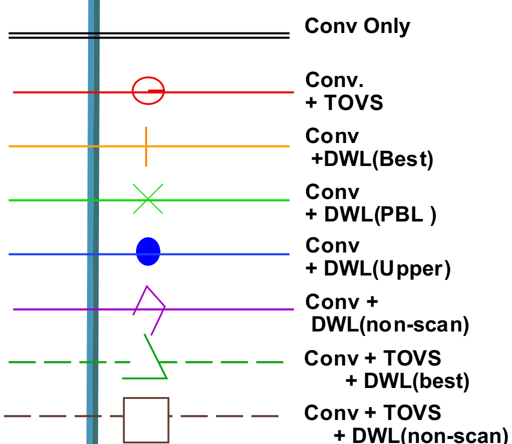
NH

SH

Total



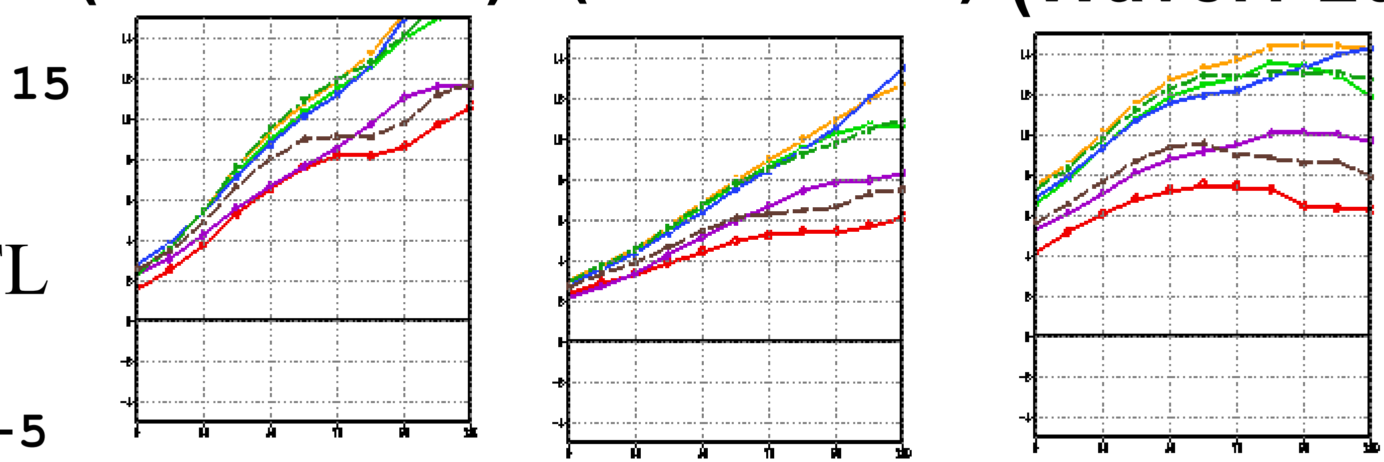




Z1000 (Wave 1- 20)

Z500 (Wave:1-20)

U500 (Wave:1-20)



Diff from CTL

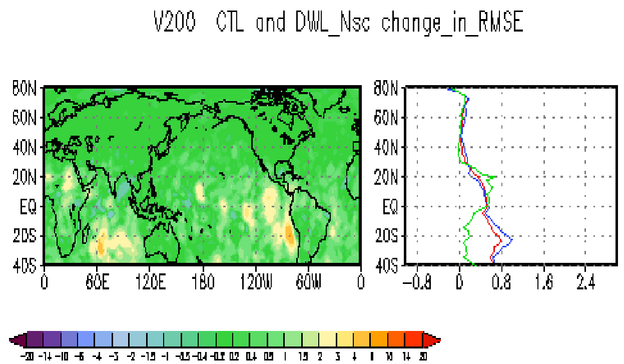
SH

TOVS shows negative impact with best DWL in SH. This could be caused by

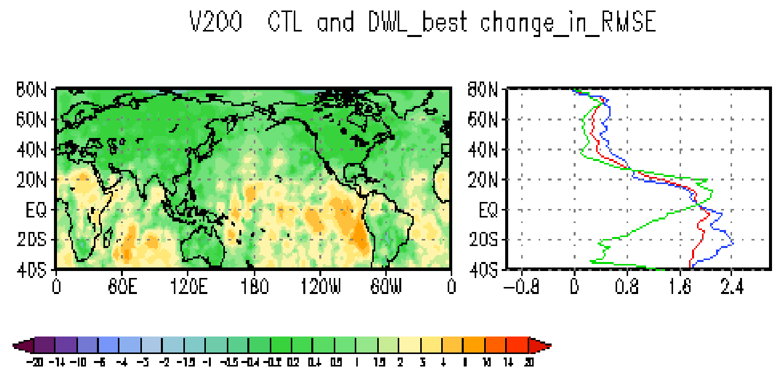
Too little weight for DWL
(tested and then answer is No)
Too much weight for TOVS
Lack of random observational error in DWL
Algorithm in SSI

Change in RMSE from NR (run_left-run_right): V 200hPa Anal
Diagram: Zonally averaged Green:land, Blue:ocean, Red:total

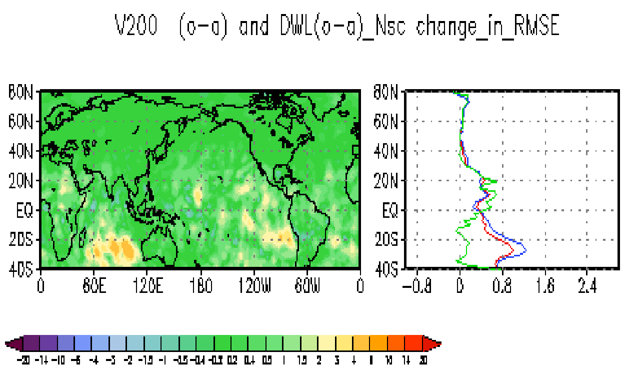
CTL(Rand):CTL(Rand)+DWL_noscan



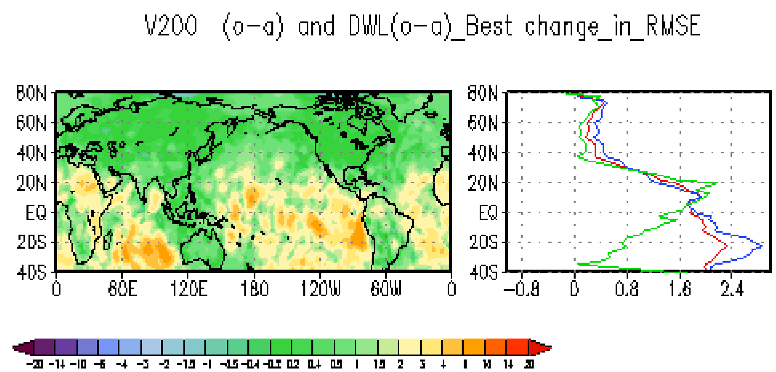
CTL(Rand):CTL(Rand)+DWL_Best



CTL(o-a):CTL(o-a)+DWL_noscan



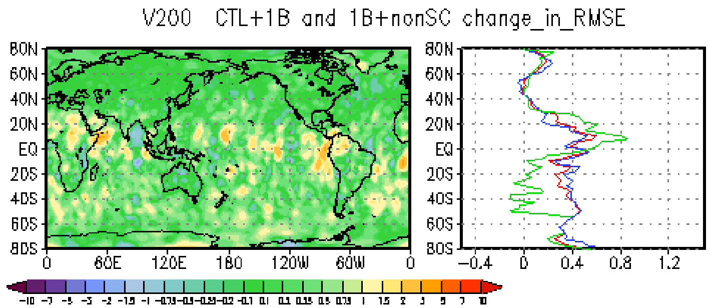
CTL(o-a):CTL(o-a)+DWL_Best



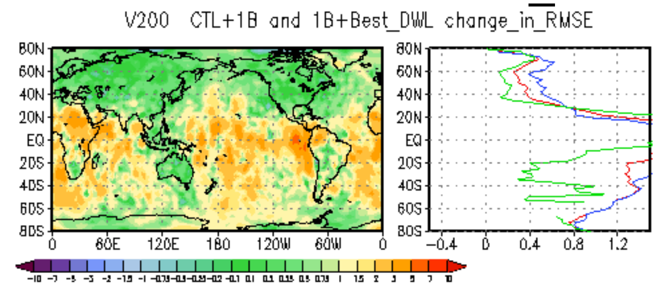
Comparison between impact of DWL and Impact of RAOB Wind.

Change in RMSE from NR in V 200hPa Analysis.
Due to withdrawing the data in the first line from the run with data with second line
Diagram: Zonally averaged Green:land, Blue:ocean, Red:total

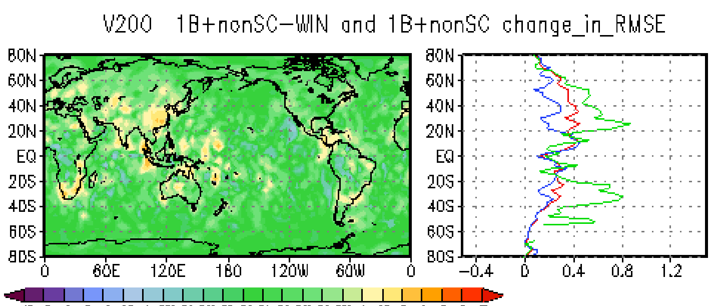
Impact of DWL_nonscan over
CTL +TOVS+ DWL_ nonscan



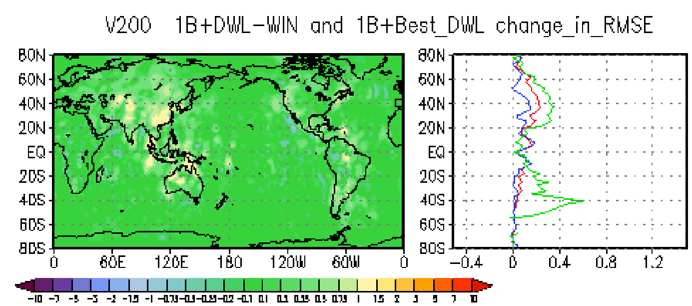
Impact of DWL_Best over
CTL+TOVS+ DWL_ best



Impact of RAOB WIND over
CTL+TOVS+DWL_nonscan



Impact of RAOB WIND over
CTL+TOVS+DWL_best



Summary

Impact of DWL at smaller scales is most significant.   More impact on V than U or T.

In NH, scanning is important to analyse sharp gradient of the winds.

Even non-scan DWL shows more positive impact than TOVS in almost all cases in Tropics and SH.

DWL significantly improve the analysis fields. Impact in forecast fields are reduced very rapidly particularly in tropics

In SH, all DWL and TOVS increase the skill significantly. With best DWL skill in SH become similar to skill in NH.

At 850hPa, skill of DWL-PBL starts off better than DWL-upper, but after 48-72 hour forecast with DWL-upper becomes better.

Summary Cont.

In SH, TOVS adds skill to non-scan DWL up to 48 hours forecasts, but slightly reduce the skill from best DWL. Skill with **DWL-best and TOVS** combined is less that best DWL only. This happen to all scales and most of the variables. This require investications.

In NH, within the time scale of the NR, the impact of DWL is not significant in large scale.

In tropics, more analysis impacts in area with large gradient of wind. It is also seen in larger scale fields.

In Tropics, due to the large difference between NCEP model and NR, forecast impact be much smaller than analysis impact.

Comments

The results need to be verified with further test with various observational error assignments.

Further development of the data assimilation and model will alter the impact. Most likely increase the impact.

Unbalanced winds cannot be estimated from temperature data. They are important for higher resolution models.

Other high density data such as AIRS may improve the skill. DWL need to be evaluated with AIRS.

DWL could be useful data to calibrate other data set such as Cloud motion vectors and radiance data.

UP to 72 hour forecast Skill in OSSE is meaningful. Beyond 72 hours similarities between models becomes the problem

The results suggensted that it may be more important to have less quality observation through out troposphere than best observation in PBL.

Comments (cont.)

In NH, case studies reveal the data impact best

Data impact of SH is affected by constant SST in NR.
Require carefull interpretation

TOVS shows negative impact with best DWL in SH. This require investigation.

From these experience recommendations for the future NR will be made.

Plans for OSSE at NCEP in 2003

A. Observational error
- Complete (o-a) tuning.
- Investigate the negative impact of TOVS.

B. Start OSSE for AIRS
- The data has been simulated
- SSI is need to adapted to OSSE.
- Need to prepare for 1993 data

C. Continue to evaluate simulation of TOVS and AIRS
- Treatment of cloud
- Formulation of observational errors
- Investigate negative impact of TOVS in SH

D. DWL
- Test more realistic DWL under development
- Test DWL with various distributions of cloud drift winds
- Test DWL with AIRS data.

Plans for OSSE at NCEP in 2003 (cont.)

D. Cloud track wind

E. Adaptive observing strategies

F. Test idealized data set

- Test the importance of divergent winds.
- Impact of extra RAOBs
- Superobbing

G. Plan for OSSE with current and future data distributions

H. New nature run

Instruments to be tested

(Simulation in progress)

OSE and OSSE

Cloud Motion Vector - *Simulated by SWA and DAO*

(Possible OSE)

Atmospheric Infrared Sounder (AIRS) and other instruments

on AQUA -*Simulated by NESDIS*

CrIS

OSSE

Doppler Wind Lidar (DWL)- *Simulated by SWA and NOAA*